

Appendix

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Definitions of ambulatory care sensitive conditions (ASCs)

Condition	ICD10 codes
Incentivized	
Asthma	J45, J46
Chronic ischaemic heart disease	I20, I24.0, I24.8, I24.9, I25
Congestive heart failure	I11.0, I13.0, I50, J81
COPD	J20, J41, J42, J43, J44, J47
Diabetes	E10.0–E10.8, E11.0–E11.8, E13.0–E13.8, E14.0–E14.8
Diabetes (hypoglycaemic)	E162
Epilepsy	G40, G41
Hypertension	I10, I11.9
Stroke	I61 I62 I63 I64 I66 I672 I698 R470
Non-incentivized	
Anaemia	D50.1, D50.8, D50.9
Cellulitis	L03, L04, L08.0, L08.8, L08.9, L88, L98.0
Dehydration	E86, K52.2, K52.8, K52.9
Ear, nose and throat infections	H66, H67, J02, J03, J04, J06, J31.2
Gangrene	R02
Nutritional deficiency	E40, E41, E42, E43, E55.0, E64.3
Pelvic inflammatory disease	N70, N73, N74
Perforated/bleeding ulcer	K25.0–K25.2 K25.4–K25.6, K26.0–K26.2, K26.4–K26.6, K27.0–K27.2, K27.4–K27.6, K28.0–28.2, K28.4–K28.6
Pyelonephritis and UTI	N10, N11, N12, N13.6, N30.0, N30.8, N30.9
Vaccine-preventable diseases	A35, A36, A37, A80, B05, B06, B16, B18.0, B18.1, B26, G00.0, M01.4

Methods

Main analysis

We describe the methods for the comparison of the incentivised ACSCs with the non-incentivised ACSCs control group to identify the effect of the P4P scheme on unplanned admissions for incentivised ACSCs. We use exactly the same procedures for the comparison of the incentivised ACSCs with the non-ACSCs control group.

The P4P scheme was approved in June of the 2003/4 financial year. This means that that primary care practices knew early in the 2003 that they would be receiving financial rewards for better quality of care in the 2004/5 financial year based on their performance over the previous 12 to 15 month period. Although precise details of the scheme were not known until shortly before its full implementation in April 2004, we also looked for an ‘anticipation effect’ in 2003/4, one year prior the scheme being fully implemented.

We based the analysis on de-trended series because there were different trends in the incentivised ACSCs and the non-incentivised ACSCs prior to the P4P scheme, this is consistent with previous approaches estimating the impact of this P4P scheme.^{1,2}

Because of large absolute differences in rates of incentivised and non-incentivised ACSC unplanned admissions we use the inverse hyperbolic sine (IHS) transformation of admission rates (number of admissions/practice registered population) in the analyses.³

$$y_{ijt} = f(Y_{ijt}) = \log(Y_{ijt} + (Y_{ijt}^2 + 1)^{1/2})$$

where Y_{ijt} is the admission rate in family practice i for admission type j ($j=0$ for non-incentivised ACSCs and $j=1$ for incentivised ACSCs) in year t . This approach is applicable when the practice had no admissions ($Y_{ijt} = 0$) and provides a value very similar to $\log(Y_{ijt})$ when Y_{ijt} is greater than zero.

We first estimated OLS regression models of IHS transformations (referred to hereafter as the log) of the practice admission rates, separately for incentivised and non-incentivised ACSC admissions, using the five years 1998/9 to 2002/3:

$$y_{ijt} = \alpha_j + \beta_j t + \gamma_i + \varepsilon_{ijt} \quad (1)$$

where y_{ijt} is the log of the admission rate in family practice i for admission type j ($j=0$ for non-incentivised ACSCs and $j=1$ for incentivised ACSCs) in year t (where t is restricted to the pre-P4P period $t = 1, 2, \dots, 5$ (1998/9, 1999/98, ..., 2002/3); γ_i is a practice level fixed effect and ε_{ijt} are practice, admission group and time specific errors.

We then compute the deviation between the log admission rate in each year for each practice and the log admission rate predicted from (1)

$$y_{ijt} - \hat{y}_{ijt} = y_{ijt} - \hat{\alpha}_j - \hat{\beta}_j t - \hat{\gamma}_i \quad (2)$$

We subtract the deviation from the pre-P4P scheme trend in the non-incentivised ACSCs from the deviation from the pre-P4P scheme trend in the incentivised ACSCs:

$$z_{it} = (y_{i1t} - \hat{y}_{i1t}) - (y_{i0t} - \hat{y}_{i0t}) \quad (3)$$

and then regress z_{it} for 1998/9 to 2010/11 on year dummies for each year:

$$z_{it} = \delta_0 + \sum_{t=2}^{12} \delta_t D_t + \varepsilon_{it} \quad (4)$$

We report the estimated year dummies in Table 1.

Supplementary analysis

We used interrupted time series analysis to test if the introduction of the P4P scheme in 2004/5 was associated with a change in the linear trend in incentivised ACSCs. This approach allows us to take into account the baseline level and trend to estimate an expected admission rate to use as a counterfactual against which we estimate the change in admissions attributable to the introduction of the P4P scheme. We used a segmented regression analysis approach which estimates an intercept and slope for the admission rate in the post-P4P scheme period and compares this with an expected admission rate (based on the pre-P4P scheme slope) if no P4P scheme had been introduced.⁴ We

fitted the financial year 2003/4 as a preparatory year using a dummy variable which omitted this data point from the estimation of the expected admission rate.⁴ Our data is for 5 years of pre-P4P data, the anticipatory year, and 7 years of post-P4P data. We used the time series regression model:

$$y_{it} = \alpha + \beta t + \delta D + \pi P_t + \lambda t P_t + \gamma_i + u_{it} \quad (5)$$

where y_{it} is the logged admission rate for incentivised ACSCs in family practice i in time t , α is the constant which estimates the log admission rate at the beginning of the series, βt is the change in the log admission rate from the start of the series in years ($t=1, \dots, 13$) and captures the baseline trend, D is a dummy variable for the preparatory year $t = 2003/4$, δ is the change in log admissions in the preparatory year where the P4P scheme was announced but not implemented. πP_t is the change in level following the introduction of the P4P scheme (P is a dummy variable taking the value 0 in the pre-P4P period and 1 in the post-P4P period), $\lambda t P_t$ is the change in trend following the introduction of the P4P scheme (where t is the number of years in the post-P4P segment and takes the values 1, ..., 7), γ_i is a family practice level fixed effect, and u_{it} are practice and time specific errors.

Table A1. Results from models of log of the admission rates in the pre-QOF period 1998/99 to 2002/03.

Non-incentivised ACSCs	Coefficient	Robust SE	p-value	95% CI
Constant	3.923	0.008	<0.001	[3.907,3.938]
Slope	0.050	0.003	<0.001	[0.045,0.055]
Non-ACSCs				
Constant	6.783	0.005	<0.001	[6.773,6.793]
Slope	0.042	0.002	<0.001	[0.039,0.046]
Incentivised ACSCs				
Constant	4.931	0.008	<0.001	[4.916,4.947]
Slope	0.017	0.003	<0.001	[0.012,0.022]

Models also included practice fixed effects.

Table A2: Estimates of the effect of the P4P scheme for above and below median levels of deprivation: differences between trend-adjusted admission rates for incentivised and non-incentivised ACSCs.

	Year	Above median deprivation			Below median deprivation		
		% difference ¹	[95% CI]	p-value	% difference ¹	[95% CI]	p-value
Pre-P4P	1998/1999	-0.014	[-0.031,0.002]	0.092	-0.011	[-0.026,0.004]	0.153
	1999/2000	0.024	[0.008,0.041]	0.004	0.018	[0.003,0.033]	0.020
	2000/2001	-0.007	[-0.024,0.009]	0.382	-0.006	[-0.021,0.009]	0.405
	2001/2002	-0.001	[-0.017,0.016]	0.939	0.003	[-0.012,0.018]	0.674
	2002/2003	-0.002	[-0.018,0.015]	0.827	-0.004	[-0.019,0.011]	0.632
Anticipatory	2003/2004	-0.010	[-0.026,0.007]	0.244	0.009	[-0.006,0.024]	0.252
Post-P4P	2004/2005	-0.031	[-0.047,-0.014]	0.000	-0.023	[-0.038,-0.008]	0.002
	2005/2006	-0.069	[-0.086,-0.053]	0.000	-0.070	[-0.085,-0.055]	0.000
	2006/2007	-0.081	[-0.098,-0.065]	0.000	-0.072	[-0.087,-0.057]	0.000
	2007/2008	-0.121	[-0.138,-0.105]	0.000	-0.091	[-0.106,-0.076]	0.000
	2008/2009	-0.081	[-0.098,-0.065]	0.000	-0.070	[-0.085,-0.055]	0.000
	2009/2010	-0.124	[-0.140,-0.107]	0.000	-0.097	[-0.112,-0.082]	0.000

2010/2011	-0.102	[-0.118,-0.085]	0.000	-0.060	[-0.075,-0.045]	0.000
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¹ The difference between the trend-adjusted admission rate for incentivised ACSCs and the trend-adjusted admission rate for non-incentivised ACSCs. The trend adjusted admission rate is the admission rate for the year minus the admission rate predicted from fitting a linear trend to admission rates for the pre P4P period 1998/90 to 2002/3.

Table A3: Estimates of the effect of the P4P scheme for above and below median levels of deprivation: differences between trend-adjusted admission rates for incentivised and non-ACSCs.

	Year	Above median deprivation			Below median deprivation		
		% difference ¹	[95% CI]	p-value	% difference ¹	[95% CI]	p-value
Pre-P4P	1998/1999	0.009	[-0.003,0.022]	0.131	-0.001	[-0.012,0.009]	0.802
	1999/2000	0.012	[-0.000,0.024]	0.053	0.013	[0.003,0.023]	0.014
	2000/2001	-0.040	[-0.052,-0.028]	0.000	-0.015	[-0.026,-0.005]	0.004
	2001/2002	0.006	[-0.006,0.018]	0.318	-0.003	[-0.013,0.007]	0.577
	2002/2003	0.012	[0.000,0.024]	0.048	0.007	[-0.004,0.017]	0.210
Anticipatory	2003/2004	0.000	[-0.012,0.012]	0.962	-0.004	[-0.015,0.006]	0.421
Post-P4P	2004/2005	-0.028	[-0.041,-0.016]	0.000	-0.027	[-0.038,-0.017]	0.000
	2005/2006	-0.085	[-0.097,-0.073]	0.000	-0.080	[-0.090,-0.069]	0.000
	2006/2007	-0.092	[-0.104,-0.079]	0.000	-0.082	[-0.092,-0.071]	0.000
	2007/2008	-0.118	[-0.130,-0.106]	0.000	-0.109	[-0.120,-0.099]	0.000
	2008/2009	-0.098	[-0.110,-0.085]	0.000	-0.112	[-0.122,-0.101]	0.000
	2009/2010	-0.138	[-0.150,-0.126]	0.000	-0.142	[-0.152,-0.131]	0.000

2010/2011	-0.109	[-0.121,-0.097]	0.000	-0.110	[-0.120,-0.099]	0.000
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¹ The difference between the trend-adjusted admission rate for incentivised ACSCs and the trend-adjusted admission rate for non-incentivised ACSCs. The trend adjusted admission rate is the admission rate for the year minus the admission rate predicted from fitting a linear trend to admission rates for the pre P4P period 1998/90 to 2002/3.

Figure A1: Estimates of the effect of the P4P scheme: percentage differences between trend-adjusted admission rates for incentivised ACSCs and non-incentivised ACSCs for above (solid) and below (hatched) median levels of deprivation.

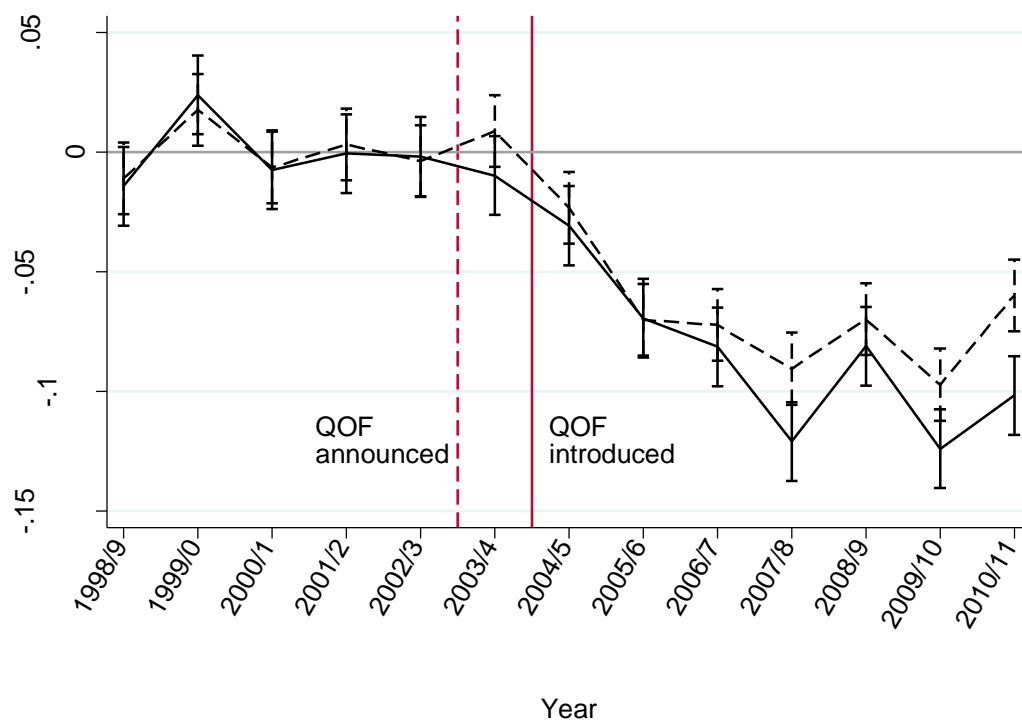


Figure A2: Estimates of the effect of the P4P scheme: percentage differences between trend-adjusted admission rates for incentivised ACSCs and non-ACSCs for above (solid) and below (hatched) median levels of deprivation.

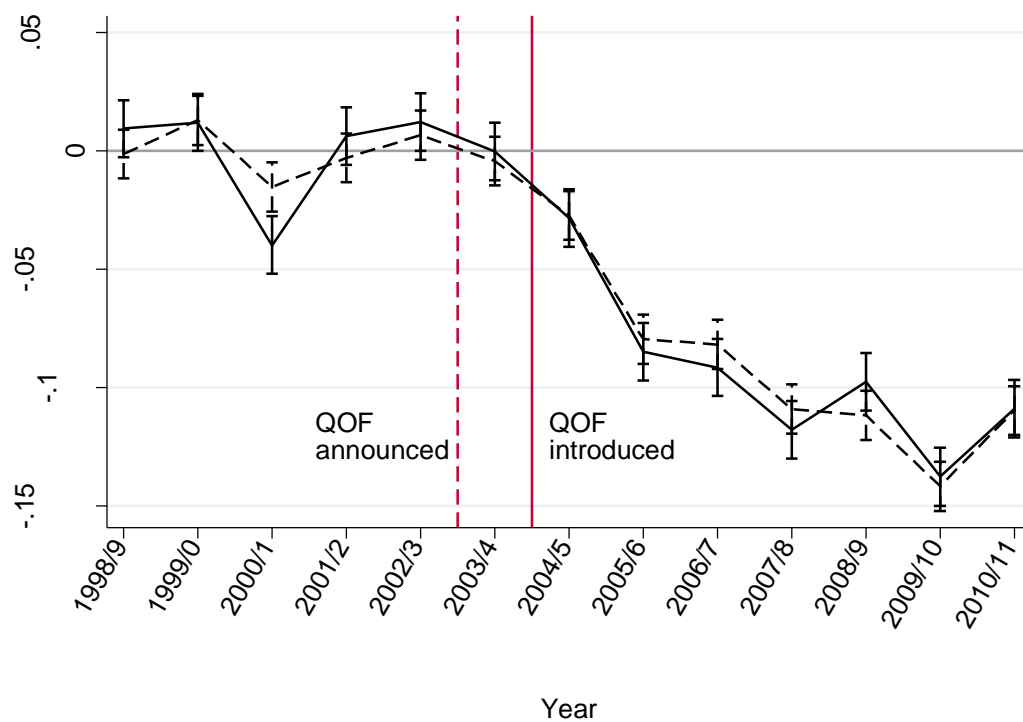
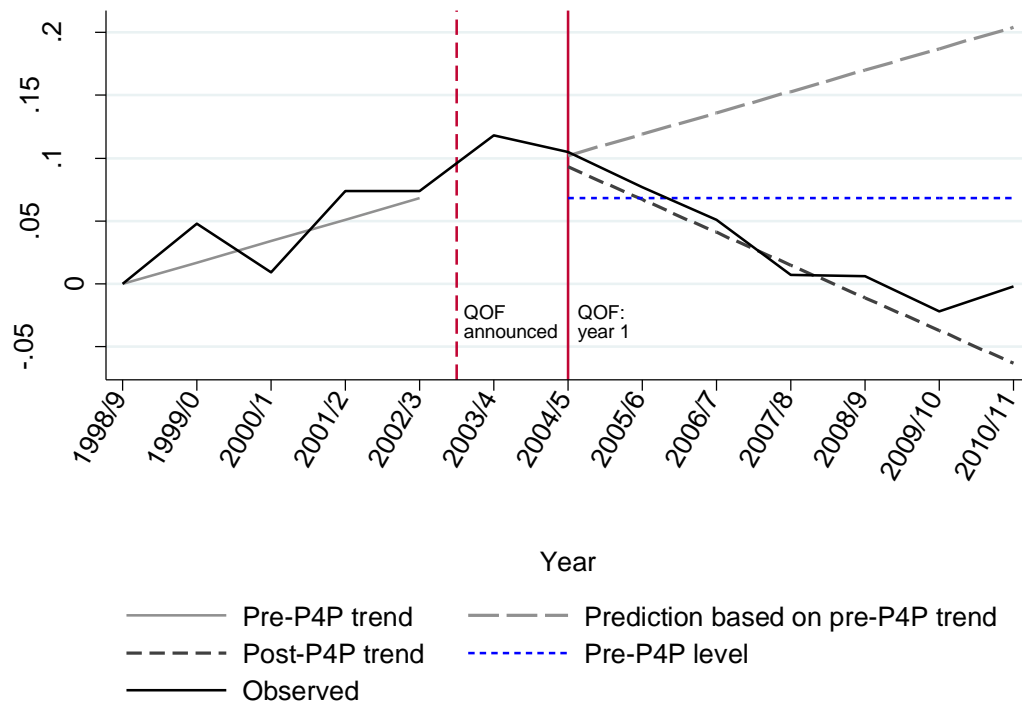


Table A4: Estimates of the proportionate change in the admission rates for incentivised ACSCs from an interrupted time series model.

	Coefficient	Robust SE	p-value	95% CI	
Constant ($\hat{\alpha}$)	137.518	0.010	0.000	134.802	140.415
Baseline trend ($\hat{\beta}$)	0.017	0.003	0.000	0.012	0.023
Anticipatory effect ($\hat{\delta}$)	0.025	0.006	0.000	0.014	0.037
Step change ($\hat{\pi}$)	0.019	0.006	0.003	0.007	0.033
Trend change ($\hat{\lambda}$)	-0.036	0.003	0.000	-0.042	-0.032

Notes: Coefficients are transformed from the log admission rate model: $\exp(\text{coeff})-1$

Figure A3: Estimates of the effect of the P4P scheme, based on an interrupted time series for incentivised ACSCs admission rates.



The vertical axis in Figure A1 is plots the proportionate difference between actual or predicted admissions in year $t = 1998/9, \dots, 2010/11$ and actual admissions in 1998/9: $\ln y_t - \ln y_{1998/9}$ or $\ln \hat{y}_t - \ln y_{1998/9}$.

Interrupted time series regression analysis indicated that there was a significant upward trend in admissions ($\hat{\beta} = 0.012$; $p < 0.001$) in the pre P4P period 1998/9-2002/3, an initial increase in the level of ACSC admission rates after the announcement of the scheme in the preparatory year 2003/4 ($\hat{\delta} = 0.034$; $p < 0.001$) and a downward trend in admissions in the post P4P period 2004/5-2010/11 ($\hat{\lambda} = -0.036$; $p < 0.001$).

The estimated effect of the P4P was to reduce unplanned admissions in 2009/10 by 26.6% (95% CI 22.0% - 31.2%) compared to the level predicted by the pre-P4P trend. A conservative estimate of the impact of the P4P scheme is to compare admissions in 2010/11 against admissions in the last year before the P4P scheme was announced (2003/4). This estimated reduction due to the P4P scheme is 14.5% (95% CI 12.9% - 16.0%).

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